Self-Healing Structural Materials for Damage Tolerant Aerospace Vehicles

Completed Technology Project (2013 - 2014)

Project Introduction

The proposed effort describes how to develop novel lightweight, self-healing systems where self-repair is induced by the forces imparted by the damage event itself. This is possible because damage is induced by an energetic source – high velocity projectile impact. By designing the molecular composition of a polymer to contain mechanoresponsive functional groups, it is possible to induce self-healing through the transformation of such chemical groups to a state where mechanical properties of the structure are almost completely restored, within fractions of seconds after the damage event occurs. The forces imparted by the damage event can therefore be used to enable healing or repair of the structure. The ability of a material to autonomically react to changes in its environment lends itself to potential applications that mitigate some of the risks that have been identified for long duration human exploration beyond LEO.

Designing and synthesizing a structural polymer matrix that has the inherent ability to self-heal within fractions of seconds after impact damage is incurred, greatly improves vehicle safety by increasing the design allowable for strength, resulting in more efficient CFRP structure. A new structural polymer is envisioned such that recovery can occur autonomously or be activated after an application of a specific stimulus (e.g. heat, radiation). Effective self-healing requires that these materials heal quickly following low - mid velocity impacts, while retaining structural integrity.

The objective of this work is to use an unconventional polymer synthetic route to develop lightweight, self-healing structural materials to enable more damage tolerant systems. The proposed work will involve the molecular design of polymers with compositions that contain mechanoresponsive chemical functional groups and the determination of synthetic conditions.

Anticipated Benefits

Self-healing structural materials to enable damage tolerant systems for aerospace and aviation have applications for NASA funded missions including, but are not limited to the following: 1. Secondary or primary structures in aircraft or spacecraft. 2. Novel approaches in MMOD protection.

Self-healing structural materials to enable damage tolerant systems for aerospace and aviation have applications for NASA unfunded /planned missions including, but are not limited to the following: Novel approaches to development of cost efficient repairable wind power blades (Green initiative).

Self-healing structural materials to enable damage tolerant systems for aerospace and aviation have applications for Commercial Space industry or

Project Image Self-Healing Structural Materials for Damage Tolerant Aerospace Vehicles

Table of Contents

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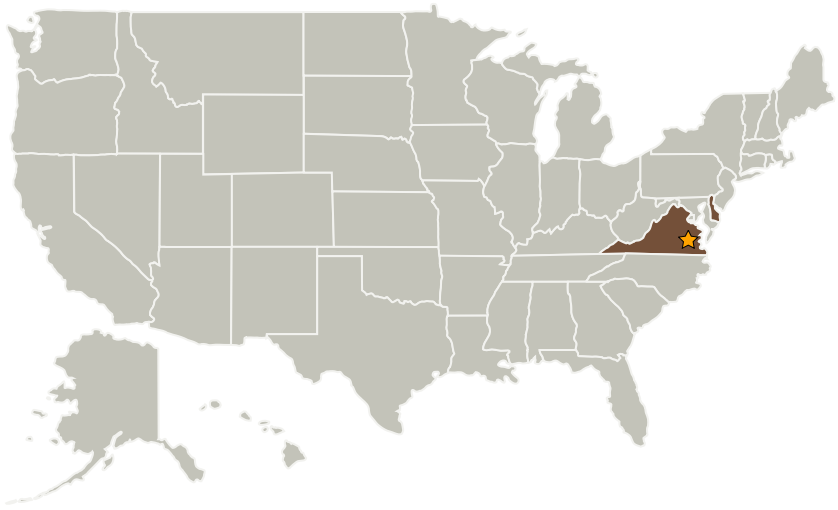
other government agencies including, but are not limited to the following: Novel approaches to fuel tank protection. Novel approaches to ballistic protection.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia

Co-Funding Partners	Type	Location
INEOS Barex	Industry	Newark, Delaware

Primary U.S. Work Locations	
Delaware	Virginia

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Center Independent Research & Development: LaRC IRAD

Project Management

Program Manager:

Julie A Williams-byrd

Project Manager:

Keith L Gordon

Principal Investigator:

Keith L Gordon

Co-Investigator:

Emilie J Siochi

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Images

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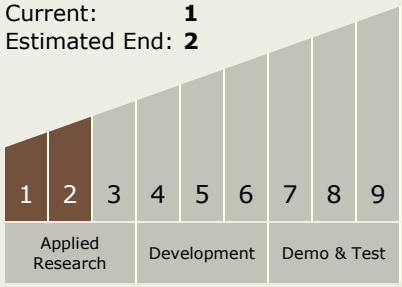
Project Image Self-Healing Structural Materials for Damage Tolerant Aerospace Vehicles
(https://techport.nasa.gov/image/2276)

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **2**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.1 Lightweight Structural Materials